International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN (P): 2249-6866; ISSN (E): 2249-7978
Vol. 7, Issue 6, Dec 2017, 21-28

HARDENED PROPERTIES OF POLYETHYLENE TEREPHTHALATE BASED CONCRETE

ANEESA MUSHTAQ, JUNED AHMAD & SAMAN KHAN

M-Tech Student, Department of Civil Engineering, Integral University Lucknow, Uttar Pradesh, India

ABSTRACT

Disposing of waste plastic materials has always been point of concern. As PET bottles are of non-biodegradable character, their decomposition is main concern regarding environmental perception. Recycling or reusing is only solution to their decomposition problem. This study deals with the experimental programme on mechanical properties of recycled polyethylene terephthalate based concrete. A Portland fly ash cement based concrete with a 0.43 water/cement ratio is used to cast cured and tested a cylindrical and cubic specimens for 7 days and 28 days strength. PET waste shredded to flakes and added with 0% to 5% with the increment of 1%, with 0% as reference concrete. Comparing with reference concrete observed an increase in compressive and tensile strength. The optimum dosage was 2% for compressive strength and 1% in split tensile strength.

KEYWORDS: PET Waste, Plastic Flakes, Compressive Strength & Tensile Strength

Received: Jul 03, 2017; **Accepted:** Jul 24, 2017; **Published:** Nov 22, 2017; **Paper Id.:** IJCSEIERDDEC20172

Original Article

INTRODUCTION

From past two decades, considerable efforts have been made towards an effective recycling of post-consumer plastics in different industrial sectors. The main cause behind, using of plastic waste is due to environmental reasons, because of their non-biodegradable characteristics and in consideration of the severe environmental problems created by the disposal of such materials in landfills, or their floating in the ocean. On the other hand, in recent years, it has been shown that in manufacturing of low-cost aggregate recycled plastic can be used. It enhances the mechanical properties of concrete. The Plastic fibre reinforced concrete with fly ash and admixture sets earlier. Concrete is brittle in nature, so to overcome such a phenomena, reinforcement came as a solution enhancing mechanical property of properties can be further enhanced by addition of fibres, as secondary reinforcement. The utilization of waste polymers has also been studied at construction of flexible pavements. In studies, authors coated the stone aggregates with molten waste plastics. They concluded that the coating of aggregates with plastics decreased the porosity, moisture absorption and improved soundness. They found that the use of waste plastics for flexible pavement was among the best methods for easy disposal of waste plastics. The bond between the fibre and aggregate, results in increase of compressive strength. The fibres provide anchorage between cement and fine and coarse aggregate which results increase in ductility. Moreover, Fibres act as stress distributers in concrete mix thus preventing deformation and crack formation. The possibility of using polyethylene terephthalate as polymer additives in Bituminous Mix has also been studied. The binders have been prepared by mixing the PET in amounts of 2%, 4%, 6%, 8%, and 10% by the weight of optimum bitumen at 150^{o}C. Results of these have showed better resistance against permanent deformations and rutting when compared to conventional binders and also that the addition of PET to bitumen increases the softening point, and as the PET

content increases the softening point temperature increases. This phenomenon indicates that the resistance of the binder to the effect of heat is enhanced and it will reduce its softening tendency in hot weather. A plastic enhances the properties of concrete as well soil as the inclusion of fiber in soil increase its cohesion value while there is no significant effects on angle of friction due to addition of fibre. So, the addition of plastic fibres is advantageous to strengthen the mechanical properties. Moreover, PET fibres incorporate in strength development of concrete to some extent and decrease the workability as it prevents the movement of aggregate. Admixtures and PET shredded flakes can be used in various proportions to improve bonding of fibres and the strength as well. The experimental study aims to study the behavior of admixture based plastic concrete for different fiber volume fractions of PET flakes.

MATERIAL USED

Cement

Ordinary Portland cement of 43 grade confirming to IS: 8112-1989 of specific gravity 3.1.

Fine Aggregate

Aggregates with specific gravity of 2.60 and fineness modulus of 2.73 are used. And the grading zone of fine aggregate is zone II, as per Indian Standard specifications IS: 383-1970.

Coarse Aggregate

Coarse aggregate of size less than 20 mm in fractions 10 mm - 40% and 20 mm - 60% with specific gravity 2.70 and fineness modulus 6.865 was used confirming to IS: 383-1970.

Admixture

SikaVisco Crete 20-HE

Fibre Water

Locally available tap water is used.

MIX DESIGN

The concrete mix is designed, as per IS: 10262-2009 IS: 456-2000 for normal concrete. We have used M25 grade with water cement ratio of 0.43. On the basis of preliminary testing of normal cubes having ratio of a suitable concrete mix, was established and water cement ratio of 0.43. Cubes of 150×150 mm and cylinders of 150×300 mm were casted and they were cured in a water tank. The various grading of coarse and fine aggregate is given in Table 1 and 2, respectively. While, the mix proportions are given in Table 3. PET flakes

Table 1: Grading of Coarse Aggregate

IS Sieve Size	Wt Retained (gm)	Cumulative Wt. Retained (gm)	Cumulative % Wt. Retained	Cumulative % Passing
40mm	0	0	0	100
20mm	300	300	6	94
10mm	3724	4024	80.5	19.5
4.75mm	976	5000	100	0
2.36mm	-	-	100	0
600 µ	-	-	100	0
300 µ	-	-	100	0

Table 1 contd.,				
150 µ	-	-	100	0
Pan	-	-	100	0

Table 2:Grading of Fine Aggregate

IS Sieve Size	Wt. Retained (gm)	Cumulative wt. Retained (gm)	Cumulative % Wt. Retained	Cumulative % Passing
10mm	0	0	0	100
4.75mm	31	31	3.1	96.9
2.36mm	62	93	9.3	90.7
1.18mm	136	229	22.9	77.1
600 µ	293	522	52.2	47.8
300 µ	353	875	87.5	12.5
150 µ	107	982	98.2	1.8
Pan	18	1000	100	0

Table 3: Mix Proportion of Concrete

Cement(kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	W/C ratio	Super Plasticizer (kg/m^3)
400.98	665.134	1196.48	0.43	1.6039

EXPERIMENTAL PROGRAM

PET fibre by weight of cement was added to the concrete mix of M 25 grade. PET fibre by percentage of 0%,1%,2%,3%,4%,5% were added to the concrete mix. 30 specimen of cube (150 mm×150 mm×150 mm) and 30 specimen of cylinder (150 mm×300 mm) were casted. For each set of percentages, 3 specimens were casted. After a curing period of 7 days and 28 days, specimen was tested for compressive strength test and split tensile strength test.

RESULTS AND DISCUSSIONS

COMPRESSIVE STRENGTH

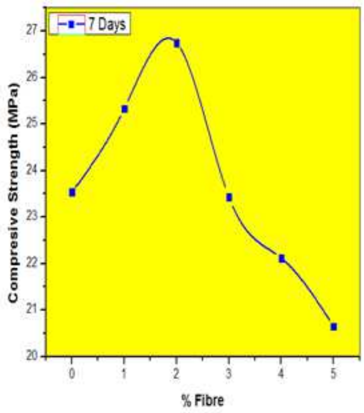
7 Days

The graph represents the 7 days compressive strength of concrete cube, with 0-5% of PET Fibre to weight of cement, 0% considered as standard concrete with strength 23.54 MPa. Fibre addition strengthens the compressive strength by 7.6% at 1% PET fibre, 13.64% at 2% fibre content and subsided 0.46% at 3%, 6.03% at 4% and 12.28% at 5% fibre content. The optimum dosage for maximum fibre content was 2% giving compressive strength of 26.75 with 13.64% increase from standard specimen. The minimum compressive strength was 20.65 with 12.28% decrease from control specimen.

Table 4: Cubes Compressive Strength, 7 Days

%Age Fibre	Compressive Strength (MPa) 7days
0	23.54
1	25.33
2	26.75
3	23.43
4	22.12
5	20.65

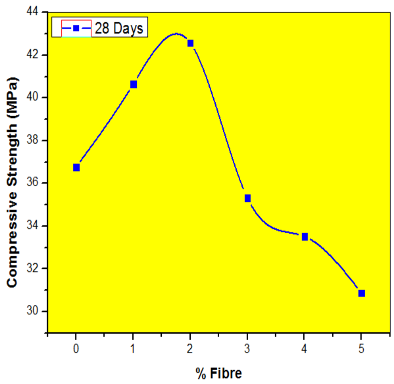
Compressive Strength at 7 Days



Compressive Strength 28days

Table 5: Compressive Strength at 28 Days

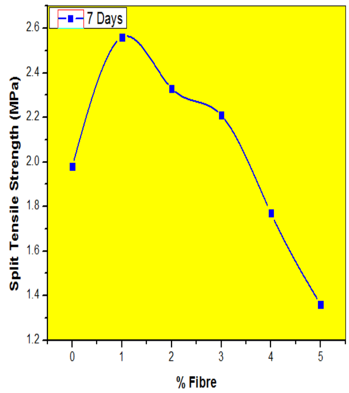
%age Fibre	Compressive Strength (MPa) 28 Days
0	36.77
1	40.65
2	42.58
3	35.33
4	33.52
5	30.87



Cubes Compressive Strength, 28 Days

The graph represents the 28 days compressive strength of concrete cube with 0-5% of PET Fibre to weight of cement, 0% considered as standard concrete with strength 36.77 MPa. Fibre addition strengthens the compressive strength by 10.55% at 1% PET fibre, 15.8% at 2% fibre content and decreases 3.91% at 3%, 8.84% at 4% and 16.04% at 5% fibre content. The optimum dosage for maximum fibre content was 2% giving compressive strength of 42.58 with 15.8% increase from standard specimen. The minimum compressive strength was 30.87 with 16.04% decrease from control specimen.

Split Tensile Strength 7 Days



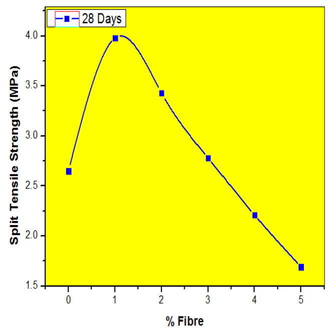
Split Tensile Strengths of 7 Days

The graph represents the 7 days tensile strength of concrete with 0-5% of Fibre to weight of cement. With the addition of PET fibre the tensile strength of concrete upgraded by 29.29% at 1% fibre content, 17.68% at 2 % fibre content, 11.62% at 3% fibre content and decreased by 10.61% at 4% fibre content, 31.31% at 5% fibre content. The optimum dosage for maximum fibre content was 1% giving tensile strength of 2.56 with 29.29% increase from control specimen. The minimum tensile strength was 1.36 with 31.31% decrease from control specimen.

Table 6: Tensile Strength at 7 Days

%Age Fibre	Split Tensile Strength (MPa) 7 Days
0	1.98
1	2.56
2	2.33
3	2.21
4	1.77
5	1.36

Split Tensile Strength 28 Days



Split Tensile Strengths of 28 Days

The graph represents the 28days tensile strength of concrete with 0-5% of Fibre to weight of cement. With the addition of PET fibre, the tensile strength of concrete upgraded by 50.19% at 1% fibre content, 29.43% at 2 % fibre content, 4.9% at 3% fibre content and decreased by 16.6% at 4% fibre content, 36.23% at 5% fibre content. The optimum dosage for maximum fibre content was 1% giving tensile strength of 3.98 with 50.19% increase from control specimen.

The minimum tensile strength was 1.69 with 36.23% decrease from control specimen.

Table 7: Tensile Strength at 28 Days

%age Fibre	Split Tensile Strength (MPa) 28 Days
0	2.65
1	3.98
2	3.43
3	2.78
4	2.21
5	1.69

CONCLUSIONS

- For compressive strength the optimum was 2% by the weight of cement with compressive strength 26.75 and 42.58 of 7 and 28 days respectively.
- For tensile strength the optimum dosage was 1% by the weight of cement with strength 2.56 and 3.98 of 7 and 28 days respectively.
- The workability is reduced as the flaky PET fibres offers resistance to aggregate movements thus it is profound to add super plasticizer in PET reinforced concrete as it enhance workability. As the fibre addition is responsible for stiff matrices while the admixture addition makes it lean.
- Standard concrete failure is brittle while the PET Fibred specimen failure pattern is ductile. Concluded that PET flakes imparts post crack response to concrete and prevents sudden failures.
- From environmental point of view the dumping issue of PET bottles could be solved as these are non-biodegradable in nature.
- PET bottles can be used in local construction or under developed regions in modifying compression and tension properties of concrete at cheaper cost and energy as it is easily available and chopped manually. Also its light weight results in light weight concrete.
- The shredded plastic flakes help in reduction of crack formation because of their holding capacity and ductile nature.

REFERENCES

1. *Dr. Mohd. Ahmed, Saiful Islam, Roohul Abad Khan. An experimental study of fibre reinforced concrete panels subjected to in-plane and flexural forces. International Journal of Engineering Associates. 2014; 3(10).*
2. *Z. N. Kalantar. Properties of bituminous binder modified with waste polyethylene terephtalate. presented at Malaysia Universities Transportation Research Forum and Conferences, December 21, 2010, UniversitiTenagaNasional.*
3. *R. Vasudevan, S. K. Nigam, R. Velkennedy, et al. Utilization of waste polymers for flexible pavement and easy disposal of waste polymers. In Proc. International Conference on Sustainable Solid Waste Management, Chennai, India; 105–11p.*
4. *ShashankVerma, Saman Khan, Roohul Abad Khan et al. Stress strain behaviour analysis of polypropylene fiber reinforced soil. International Journal of Research in Emerging Science and Technology. 2105; 2(12).*
5. *Ms. K. Ramadevi, Ms. R. Manju. Experimental investigation on the properties of concrete with plastic pet (bottle) fibres as fine aggregate. International Journal of Emerging Technology and Advanced Engineering. 2012; 2(6).*

6. *Z. N. Kalantar. Properties of bituminous binder modified with waste polyethylene terephtalate. presented at Malaysia Universities Transportation Research Forum and Conferences, December 21, 2010, UniversitiTenagaNasion.*

7. *S. Faiz U. Ahmed, M. Maalej, P. Parmasivam. Construction and building materials. Elsevier Journals. 2007; 21: 1088–1097p.*